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PRACTICAL TREE SURGERY.

BY

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INTRODUCTION.

SOME eminent botanical writers have stated that if all the external factors which influence the growth of a tree are favorable there is no theoretical reason why it should not live in a healthy condition and increase in size indefinitely. These statements obviously are based upon the well-known fact that the increase in the size of a tree trunk is due mainly to the new layer of wood which is formed each year beneath the bark on the outside of the old wood. If a tree were never attacked by insects or by organisms which cause decay, never injured or broken by storms or mutilated by men or animals, there undoubtedly would be a much greater number of large and healthy trees than exist at the present time. Probably no tree ever experienced the ideal conditions suggested above, not even for a comparatively brief period of its existence. Consequently, the conditions that we commonly regard as normal or average for tree growth are really far from ideal. Throughout its life a tree is subject to injury by insects, mechanical forces, and disease. Again, trees, like human beings, may become unhealthy as a result of improper food, air, or water, or an insufficient amount of either, or they may become sickly and die from the effects of noxious gases.

In considering the subject of tree surgery it is important, first, to become familiar in a general way with the parts of a tree which are directly involved, their structure, their importance to a living tree, and how they are affected by the surgical methods employed. Owing to the lack of this knowledge, many serious blunders have been made in connection with the care of mutilated, injured, and diseased trees.

PARTS OF A TREE AND HOW THEY WORK.

GENERAL DISCUSSION.

A tree is composed of three main parts—the root, the stem (trunk and branches), and the leaf. The roots serve not only for anchorage, but are the main passages for the entrance of water into a tree. Practically no water enters elsewhere. It enters chiefly through the very small roots, passes into the larger roots, then up the trunk, and out into the larger and smaller branches to the leaves. In moving from the roots to the leaves it passes mainly through the sapwood (Pl. XVI, fig. 1, *b*), that portion of the wood which lies immediately beneath the bark and cambium. The sapwood is of a lighter color in many trees than the heartwood (Pl. XVI, fig. 1, *a*) in the central portion of the trunk and limbs, and varies in thickness from a quarter of an inch to 2 inches or more, according to the kind of tree. The heartwood is practically dead tissue and gives rigidity to the tree. It is not active in conducting sap, and thus it may often be partially or completely removed without causing serious injury to the tree beyond impairing its strength.

Not so with the sapwood, for if any great amount of this, as measured around the trunk, is removed, the tree may be seriously injured or killed. Since the sap moves upward primarily through the microscopic tubes which run lengthwise in the sapwood of roots, trunk, and limbs, it is possible to remove a long and narrow strip of sapwood extending parallel with these tubes with less injury to the tree than would result from cutting out a shorter and smaller, but broader, area to an equal depth. This is due to the fact that the broader cut severs and renders useless a greater number of these sap-conducting tubes.

When the water finally reaches the leaves, the larger part of it escapes in the form of vapor. Unless the water which is lost by evaporation is promptly and constantly replaced from the soil by the roots, wilting will result. Should this wilted condition continue for any great length of time the tree, or portions of it, may be permanently injured. Wilting may also result from certain abnormal conditions, such as a sudden application of common salt or other chemicals to the soil around the roots, or the removal of portions of the sapwood, or the cutting of the roots.

The tree manufactures its own food. In its simpler forms this consists of sugar and starch, which are made from carbonic-acid gas and water. This work is done only during daylight and almost entirely in the green leaves. Mineral substances are dissolved in the water which enters the tree from the ground. Some of these are of vital importance to the tree and are used in the making of certain more complex kinds of food, though not in the formation of sugar and starch. When formed, the foods are carried through microscopic conducting tubes in the inner bark to those parts of the tree where growth and repair are actively going on and are soon transformed into new tissues or stored at convenient places for future use. While being transported, the foods are dissolved in water, which is present in great abundance in all living parts of the tree.

If a ring of bark completely encircling (girdling) a limb be removed, practically all of the food matter formed in the leaves beyond the girdled area will remain in the limb. This usually results in an enlargement of the limb immediately above the girdled area or in an unusual enlargement of fruits or flowers, provided there are many healthy leaves and only a few fruits or flowers beyond the girdled area. The flow of water in the sapwood from the roots to the leaves is not immediately affected to any extent by removing the bark, although the limb later dies as the sapwood becomes dry beneath the girdled area. If both bark and sapwood are removed, the limb beyond dies very soon.

CAMBIUM.

From the standpoint of tree surgery the most important portion of a tree is the very thin, usually watery, layer of young tissue located between the bark and wood of all healthy parts of a tree. This is the cambium (Pl. XVI, fig. 1, *c*). It is the layer that splits or slips so easily when the bark is removed in making the familiar willow whistles in the spring. During the growing season it is constantly giving rise to new cells on both sides; on the outer to new layers of bark cells, on the inner to new layers of wood cells. This results in the youngest wood being on the outside of the old wood and the youngest bark on the inside of the old bark. If a portion of

the cambium is killed, no more new wood or bark can again be formed under or over this area. The living cambium surrounding the dead area will, however, give rise each year to a new layer of wood and bark unless growth is inhibited by disease or further injury. This new growth will gradually push out over the dead area and may eventually cover it (Pl. XVI, figs. 2, 3, and 5). Such dead spots furnish favorable points for the entrance of insects and organisms which cause decay.

The formation of all new wood and bark and the healing over of all cut stubs and dead areas are due solely to the activity of the living cambium; consequently, it is of utmost importance that the cambium be protected from injury at all times. Many failures in tree-surgery work have been due wholly to injuries to the cambium. During the winter the cambium remains alive but inactive, and is then least liable to injury. In the spring, when the buds and leaves are unfolding, it contains much water, is actively growing, and is then most susceptible to injury.

CORKY OUTER BARK.

The oldest bark is on the surface of the trunk and limbs and is composed of dead, corky tissues which are constantly being worn away in the form of small fragments by the action of wind, rain, and other external agencies (see Pl. XVI, fig. 1, *e*). Parasitic diseases and organisms which cause decay can rarely gain entrance into the interior of a trunk or limb if this dead, corky bark and the cambium beneath it remain uninjured.

OBJECT OF TREE SURGERY.

It is a well-known fact that trees are subject to all sorts of injuries, from sources too numerous to mention. In a great majority of cases these injuries are allowed to remain untreated—often for years. Rot-producing fungi commonly gain entrance at these places, and eventually the original inconspicuous or unobserved injury develops into a comparatively large area of decay. The real aim of tree surgery is to repair the damage resulting from such neglected injuries and rotted areas.

PRINCIPLES INVOLVED.

In most tree-surgery work a few fundamental principles must be observed in order that permanent good results may be realized. These may be summarized as follows: (1) Remove all decayed, diseased, or injured wood and bark. When on small limbs, this can often best be done by removing the limb. On larger limbs or on the trunk it may at times mean the digging out of a cavity. (2) Sterilize all cut surfaces. (3) Waterproof all cut surfaces. (4) Leave the work in the most favorable condition for rapid healing. This will often mean the filling of deep cavities. (5) Watch the work from year to year for defects. If any appear they should be attended to immediately.

QUALIFICATIONS OF WORKMEN.

Tree surgery, or, more properly, tree repair work, is not a mysterious art known only to a favored few who alone are fitted to undertake it, as some interested persons would have tree owners believe. It can be undertaken by any careful man who has a good general knowledge of the structure and life history of a tree, its normal manner of covering wounds, and how insects and decay organisms cause damage, provided he can handle a gouge and mallet, a saw, and a tar brush and applies in a practical manner his knowledge of the anatomy of a tree, together with a generous admixture of good common sense. For work in the tops of trees he will also need a clear head and ability to climb. Many tree owners and many persons in charge of private estates are well qualified to undertake tree surgery if the requisite time is available and they will familiarize themselves with the fundamental principles and operations underlying the work, at least to the extent presented in this article.

The impression should not be gathered from what has just been said that there is no advantage in practice and training of the proper kind. On the contrary (in commercial work, particularly), practice and training develop speed in working and quickness in determining the right thing to be done, but they do not necessarily mean any greater care or thoroughness in the work. It is safe to say that a man who takes care of his own trees or carefully supervises the

work of those attending to them will be likely to know definitely whether or not the work is thoroughly and properly done.

METHODS IN TREE SURGERY.

PREVENTIVE MEASURES.

It is no easy matter to find a place where the well-worn phrase "prevention is better than cure" could be applied with greater appropriateness than in connection with tree surgery. Ice or wind may break limbs or uproot trees which injure others as they fall. Horses commonly gnaw away portions of the bark of street trees unprotected by tree guards. Telephone, telegraph, and electric linemen with their climbing spurs and saws are notorious mutilators of shade trees, especially in towns where the trimming of trees is not regulated by law. Poorly insulated electric wires of high voltage often discharge heavy currents through the trees. Wheel hubs frequently tear away large pieces of bark. After a few years, decay may penetrate into the interior of the tree from any or all of these injured places (Pl. XVI, fig. 4). This decay may increase from year to year until large limbs, or the trunk itself, become so weakened that they are easily broken by violent storms (Pl. XVI, fig. 6). It requires comparatively little time and expense to clean and paint a fresh injury. It often requires much time and expense to treat properly the same injury after it has been neglected for a few years. Almost every large decayed cavity has resulted from an injury which would have required comparatively little time and effort to clean, sterilize, and waterproof at the time it occurred. The most economical and reliable remedy for a decayed area consists in attending to an injury as soon as it is made, perhaps 20 or 30 years before it becomes a menace to the tree. This fact should never be forgotten by tree owners or persons who are charged with the care of trees. If put into practice, it will insure a profit of many hundred per cent on the original outlay.

TYPES AND SCOPE OF WORK.

In its simplest type, tree surgery, as it is popularly understood at the present time, consists in removing dead or decayed limbs or stubs from a tree and treating the scar

with an antiseptic and waterproof covering to prevent decay while healing. Another type consists in cutting out the decayed and diseased matter in trees and filling the cavities with cement or other material to facilitate the normal healing-over process. This is often referred to as "tree dentistry," a term which very aptly indicates the character of the work. Filled cavities do not increase the strength of the trunk or limb to the extent that is generally supposed.

DEAD OR DISEASED BRANCHES.

The work under this heading can be regarded as comprising but two essential operations: (1) Removing the branches in a manner that will prevent injury to the surrounding bark and cambium, and (2) sterilizing and waterproofing the scars.

REMOVING BRANCHES.

For the work of removing branches, the most essential implements are a good-sized saw with teeth so set as to make a wide cut, a gouge, a chisel, a mallet, and a strong knife. For cutting limbs near the ground these are the only necessary implements. For limbs situated elsewhere a ladder may be needed; also, at times, a rope.

A large limb should never be removed by sawing through from the upper side, as this usually strips the bark and wood below the scar (Pl. XVII, fig. 1). The proper way is to make the first saw cut on the under side, from 6 inches to a foot beyond the point where the final cut is to be made (Pl. XVII, fig. 2). It should reach from one-fourth to one-half through the limb. A good time to stop cutting is when the saw becomes pinched in the cut. The second cut is made on the upper side of the limb, an inch or two beyond the first one. This is continued until the limb falls (Pl. XVII, fig. 5). After the limb has fallen, a third cut is made close to the trunk and in line with its woody surface (Pl. XVII, fig. 4). When nearly sawed through, the stub must be supported until completely severed, so as to avoid any possibility of stripping the bark below as it falls (Pl. XVII, fig. 1). The first and second cuts to prevent stripping may be omitted when small limbs which can be held firmly in place until completely severed are being cut.

When the scar is not naturally pointed above and below, it is a good practice on most trees to remove a short triangular piece of bark from the upper edge of the scar and another from the lower edge (Pl. XVII, fig. 3), so as to anticipate its dying back at these points. This makes the scar pointed at both ends, the most favorable shape for healing. It is important that some good shellac be applied with a suitable brush over the edge of the bark, especially the cambium, immediately after the cut is made. If the scar is a large one, it is a good plan to use the knife for one or two minutes and then shellac the freshly cut surfaces, repeating the operation until all the bark around the scar has been shellacked. The full benefit of the shellac will not be achieved if many minutes elapse between the cutting and the shellacking, unless the freshly cut surfaces are visibly moist with sap.

If necessary, the woody surface of the scar may now be smoothed off with a chisel and mallet to conform in general shape with the tree trunk. It is bad practice to leave a stub projecting from a trunk, as shown in Plate XVII, figure 6.

ANTISEPTIC AND WATERPROOF DRESSINGS.

The final operation is to sterilize and waterproof the surface of the exposed wood and bark. For this purpose many preparations have been used. Recent extensive tests by specialists in timber preservation indicate that some of the creosotes stand far ahead of all other tested preparations in their power to destroy and prevent the growth of certain wood-destroying fungi and that ordinary creosote, although it does not head the list, is far better than other preparations except some of the less known and less available creosotes. Furthermore, creosote penetrates the wood better than a watery antiseptic. In using commercial creosote, it can be applied with an ordinary paint brush over every part of the exposed wood. The entire shellacked and creosoted surface must finally be waterproofed by painting it with heavy coal tar. A single application of a mixture of creosote and coal tar (about one-fourth or one-third creosote) has been quite extensively used with good results. Although one coating of this mixture may at times be sufficient, it is always safer to follow it with a heavy coat of coal tar.

A good grade of lead paint can be substituted for the tar, if desired, although it is not generally considered as satisfactory; or grafting wax may serve satisfactorily for small surfaces. Asphalt and various preparations containing asphalt are excellent waterproof coverings and would doubtless be more generally used were it not necessary to apply them hot. A good and possibly more permanent method of treating the scars is to char the surface slightly with a gasoline or alcohol blast torch and then cover the hot surface with heavy tar or hot asphalt. Although heat is an excellent sterilizing agent, it does not penetrate so well as creosote and it kills back the cambium to a greater extent.

Permanent waterproofing can be secured only when the treated surfaces are watched from year to year and recoated when any tendency to crack or peel is observed. This is an important step, which is almost invariably neglected by tree owners and tree surgeons.

TREATMENT OF CAVITIES.

During the last few years there has been a widespread popular interest in the treatment of decayed places in old trees. Many inquiries addressed to the Department of Agriculture refer solely to methods employed in cementing cavities. This is a logical result of the present extensive use of cement in filling tree cavities. This type of work will first be considered. It can be regarded as comprising three essential operations: (1) Removing all decayed and diseased matter, (2) sterilizing and waterproofing all cut surfaces, and (3) filling the cavity in a manner that will favor rapid healing and exclude rot-producing organisms.

TOOLS.

The necessary tools for digging out decayed matter are few. As a rule, two outside-ground socket-handled gouges (one with a curved cutting edge of about three-fourths of an inch and the other, perhaps, 1½ inches), a chisel, a mallet, a knife, and an oilstone are sufficient for ordinary work. The gouges, chisel, and knife should never be used near the cambium when they lack a keen edge, as dull tools will injure it. In cutting out deep cavities, longer interchangeable handles for the gouges may be necessary. A ladder or

a stepladder will be required if the work is more than 5 feet from the ground.

EXCAVATING.

Usually an old decayed spot may be partially or wholly covered by a new growth of wood and bark at the edges and the visible decayed area be small as compared with that which is hidden. (See Pl. XVI, figs. 4 and 6.) In such cases it is usually necessary to enlarge the opening with the gouges and mallet in order to make sufficient room in which to use the gouges in the interior. This opening should not be any wider than is necessary, for reasons already stated in discussing sapwood, but it may be sufficiently long to reach all the decayed and diseased heartwood with little or no additional injury to the tree.

If the decayed and diseased wood extends some distance above or below the external opening, it is a common practice to cut one or more holes above or below the main opening in order to facilitate the removal of the diseased wood (Pl. XVIII, fig. 1). This results in one or more bridges of wood and bark spanning the long interior cavity. This practice is of doubtful value, partly because it is often impossible to see whether the diseased wood has been entirely removed from the under side of the bridges, but mainly because there is a strong tendency in most trees for the bark and sapwood of the bridges to die and decay as a result of severing the sap-conducting tubes both above and below. If the holes are pointed above and below, there is less trouble from this source. A practice that permits a more thorough cleaning out of the cavity is to make a narrow opening, pointed at both ends and sufficiently long to include all the diseased wood. This often extends some distance above and below the visible discolored area.

The most important feature of this stage of the work is to remove all the diseased and insect-eaten wood (Pl. XVIII, figs. 2 and 3). This excavating must continue on all sides of the cavity until sound, uninfected wood is reached. (See Pl. XVI, fig. 4.) All discolored or water-soaked heartwood should be removed, as this is the region in which the rot-producing fungus is most active. In decayed areas of many years' standing there may be only a thin shell of uninfected wood around the cavity (Pl. XVI, fig. 6), in which case there is

danger of the tree being broken by storms unless braced or guyed, as indicated later under "Guying."

DRAINAGE.

The bottom and all other parts of the cavity should be so shaped that if water were thrown into the cavity it would promptly run out and none remain in any hollow. This feature is commonly called "drainage." It is bad practice to have a deep water pocket at the bottom of a cavity with drainage through an auger hole bored from the exterior. An open hole of this sort often becomes a favorable lodging place for insects or fungous spores.

UNDERCUTTING.

Another important point to be borne in mind in shaping a cavity that is to be filled is to have the sides undercut if possible, so as to hold the filling firmly in place. Care must be taken, however, not to have the wood at the edges of the opening very thin, as this promotes the drying out of the bark and sapwood at these points. Ordinarily the edges should be at least three-fourths of an inch thick; an inch and a half would be better (Pl. XVI, fig. 4, and Pl. XIX, fig. 1). Inrolled bark at the edges of an opening should be cut back in nearly parallel radial planes, as a rule, to a point which will permit the surface of the completed cement filling to conform with and continue across the cavity the general contour of the woody part of the trunk (Pl. XIX, fig. 1). If it is not possible to undercut sufficiently to hold the filling firmly in place, the alternative method described under "Nailing" can be adopted (Pl. XIX, fig. 2).

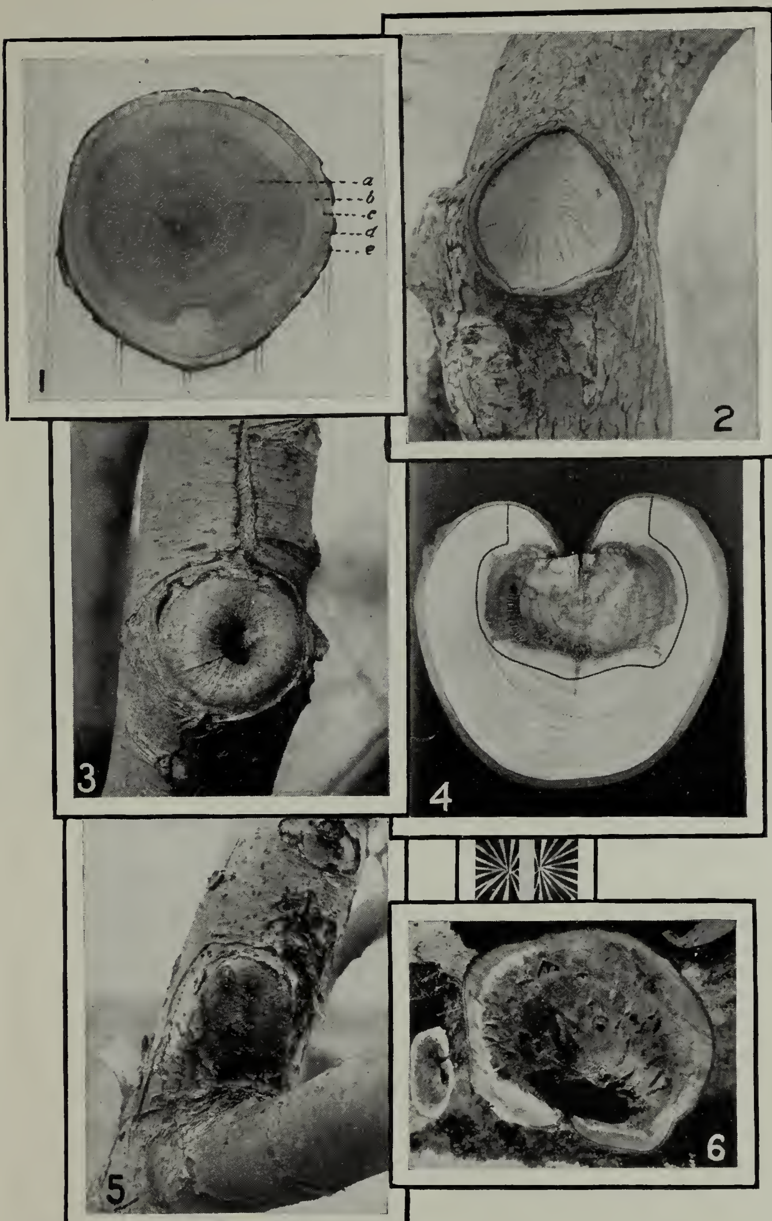
As already stated, great care must be exercised in working around the cambium, and all cutting tools must be kept very sharp. The final cutting along the edges of the bark and sapwood can usually best be made with a very sharp knife. This cutting must be followed immediately by a coating of shellac, which should cover the edges of both bark and sapwood.

BOLTING.

Before cementing a long cavity it is advisable to place through it one or more bolts, so as to hold the wood and cement more firmly in place. A cavity 2 feet or less in

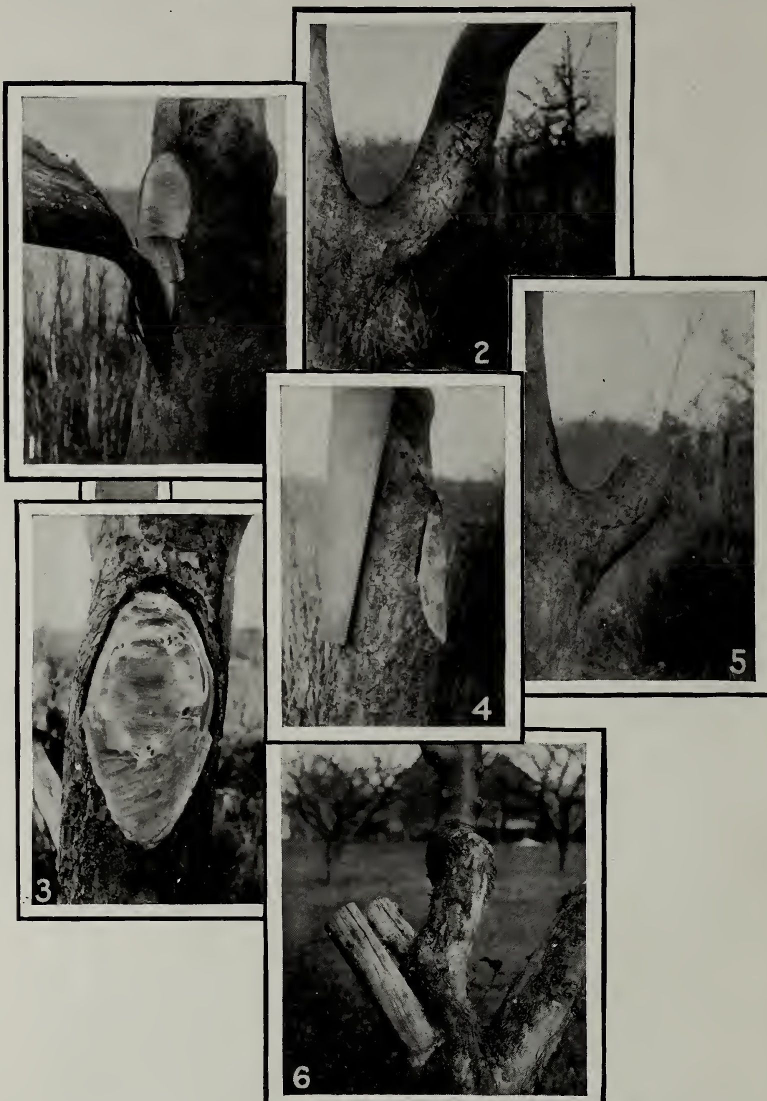
length will not usually require a bolt, but long cavities, as a general rule, should be bolted every 18 to 24 inches. Oftentimes a single bolt can be placed so as to support both sides (Pl. XIX, fig. 2). In certain cavities it may be necessary to place bolts at different angles (Pl. XIX, fig. 3). In any case a strip of uninjured cambium at least an inch wide should be left between the edge of the cavity and the bolt. On medium-sized trunks, after deciding where the bolts can most efficiently be placed, a very sharp half-inch bit, sufficiently long to reach through the trunk and cavity, can be used to bore the hole for the bolt. On large, heavy trunks a larger bit should be used. Heavy oval or round iron or steel washers, about three times the diameter of the bolt, should be countersunk into the wood by carefully cutting away the bark at both ends of the hole with a sharp gouge or chisel (Pl. XIX, figs. 2, 3, and 4). The washers should be heavy and ample, but not so broad as to necessitate cutting away a large piece of bark. In most trees when round washers are used it is advisable to have this countersunk area somewhat pointed above and below the washer, for reasons already mentioned. By holding the two washers in place, the length of the steel machine bolt can be determined by measuring through the hole. The bolt must be thick enough to fit snugly in the hole and should project beyond each washer for at least one-fourth inch. The thread at each end of the bolt must be sufficiently long to permit drawing in the sides of the cavity a little as the nuts are screwed up against the washers. A chamfered single-headed bolt may be used, if preferred. Before the bolts are finally put in place the countersunk cuts and bolt holes should be tarred or creosoted, and after the bolts are in place all exposed parts of the bolts and nuts should be tarred.

All split cavities must be securely bolted, particularly near the upper part. If the split comes from a crotch, all decayed and diseased wood should be removed from the split and creosote and tar applied, after which it can be bolted just beneath the crotch, so as to close the crack or at least bring the parts back to their normal position in case decayed matter has been excavated from the crack. If the split is a recent one, a washing of creosote only will usually



PROPERLY TREATED INJURIES, SHOWING NORMAL HEALING, AND UNTREATED INJURIES, SHOWING NORMAL PROGRESS OF DECAY.

Fig. 1.—Cross section of a tree trunk showing location of parts: *a*, heartwood; *b*, sapwood; *c*, cambium; *d*, bark; *e*, corky outer bark. Fig. 2.—A scar beginning to heal over. (Note that it heals more rapidly at the sides than at the top and bottom.) Fig. 3.—A scar about three-quarters healed over. Fig. 4.—Cross section of a 7-year-old blaze on a quaking aspen which has nearly healed over. (Note the large area of decay which originated at the ax cut. The line on the wood indicates the proper shape of the cavity if this had been excavated.) Fig. 5.—A scar from a cut limb entirely healed over. Fig. 6.—End of a log, showing a small opening into the large decayed area; only a shell of scund wood remains.

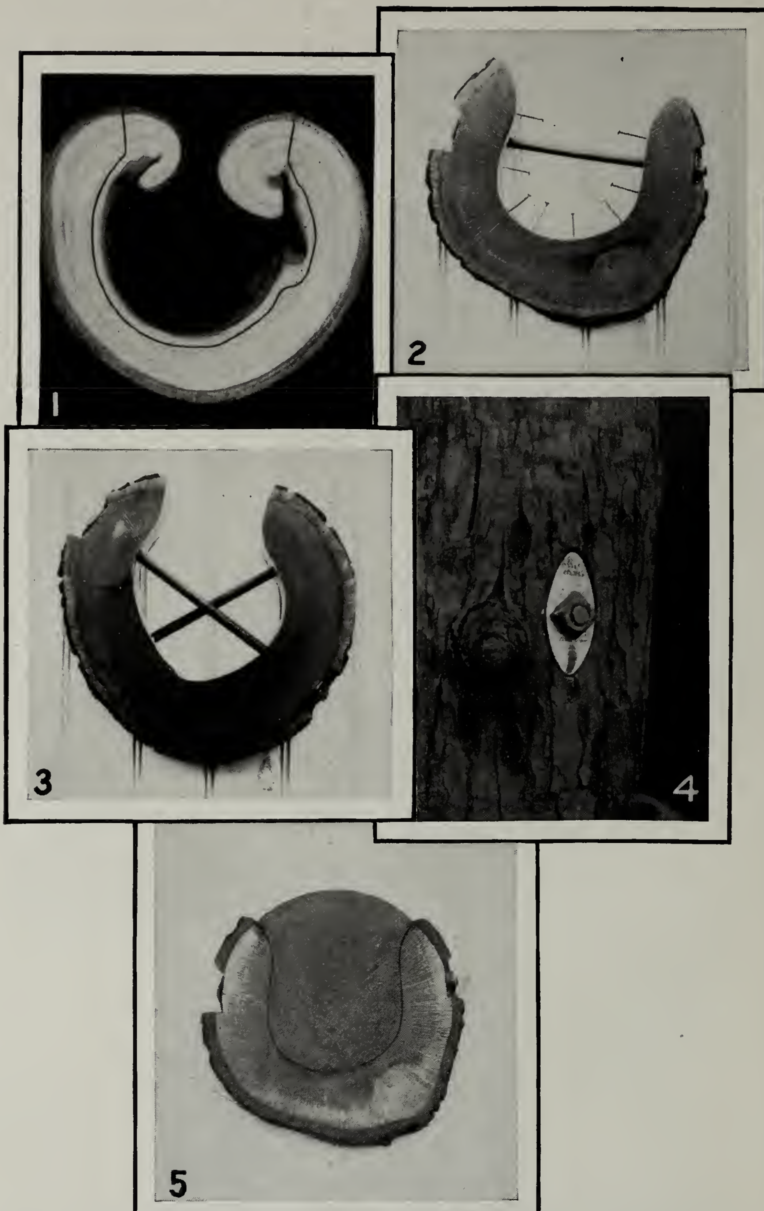


REMOVAL OF LARGE LIMBS, SHOWING PROPER AND IMPROPER METHODS.

Fig. 1.—A heavy limb improperly cut, showing the stripping as the limb falls. (Compare with Figs. 2, 5, and 4.) Fig. 2.—Removing a heavy limb; the first cut on the under side is to prevent stripping. Fig. 3.—Removing a heavy limb; the oval scar has been somewhat pointed with a gouge above and below to facilitate healing. Fig. 4.—Removing a heavy limb; the third cut to remove the stub shown in fig. 5 has been completed. Fig. 5.—Removing a heavy limb; the second cut completed; the limb has fallen without any stripping. Fig. 6.—Improperly cut and untreated stubs. The bark of these stubs died mainly as a result of severing all the food-producing organs (leaves) above; decay has entered the trunk from these stubs. (Note that the successive stages in removing a heavy limb are shown in figs. 2, 5, 4, and 3, in the order indicated.)

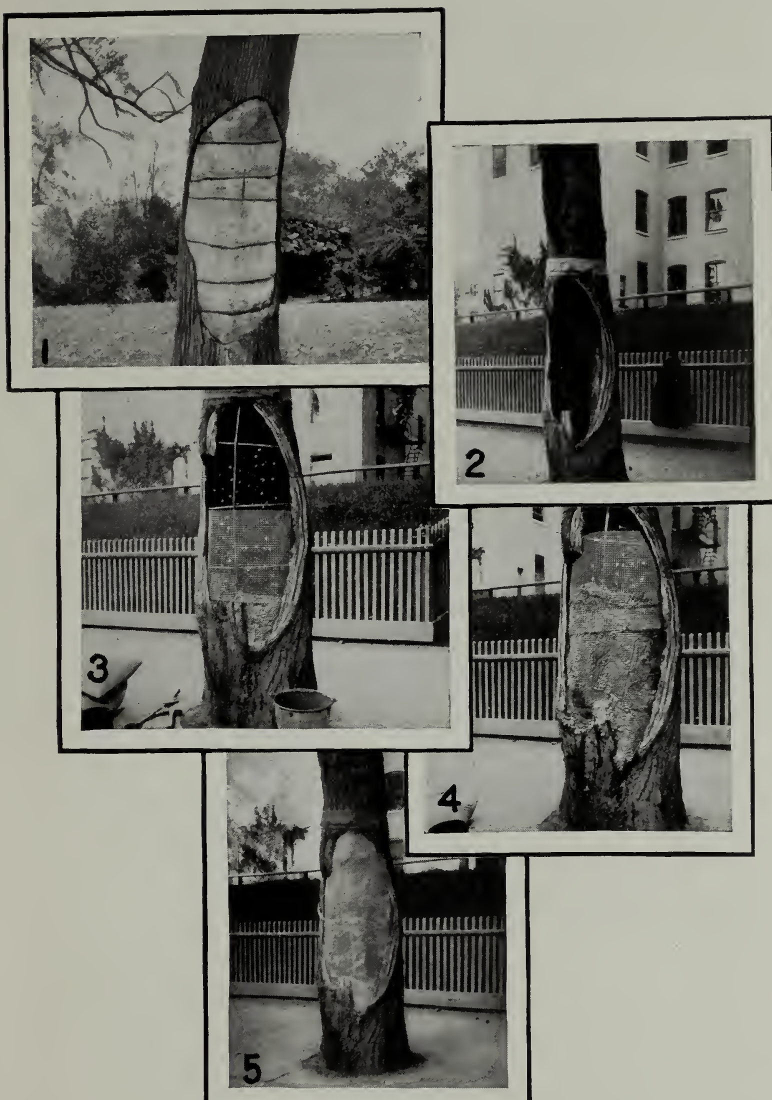
LONG CAVITIES EXCAVATED THROUGH SEVERAL OPENINGS AND A SHORT CAVITY EXCAVATED THROUGH ONE OPENING.

Fig. 1.—Cavities in two trees excavated through small openings cut in the trunk. It would be better to make the openings oval and pointed rather than square or round. Fig. 2.—An old injury caused by horses gnawing the bark. Fig. 3.—The injury shown in fig. 2 excavated and ready for tarring prior to filling.



DETAILED VIEWS OF EXCAVATED, BOLTED, AND CEMENTED CAVITIES.

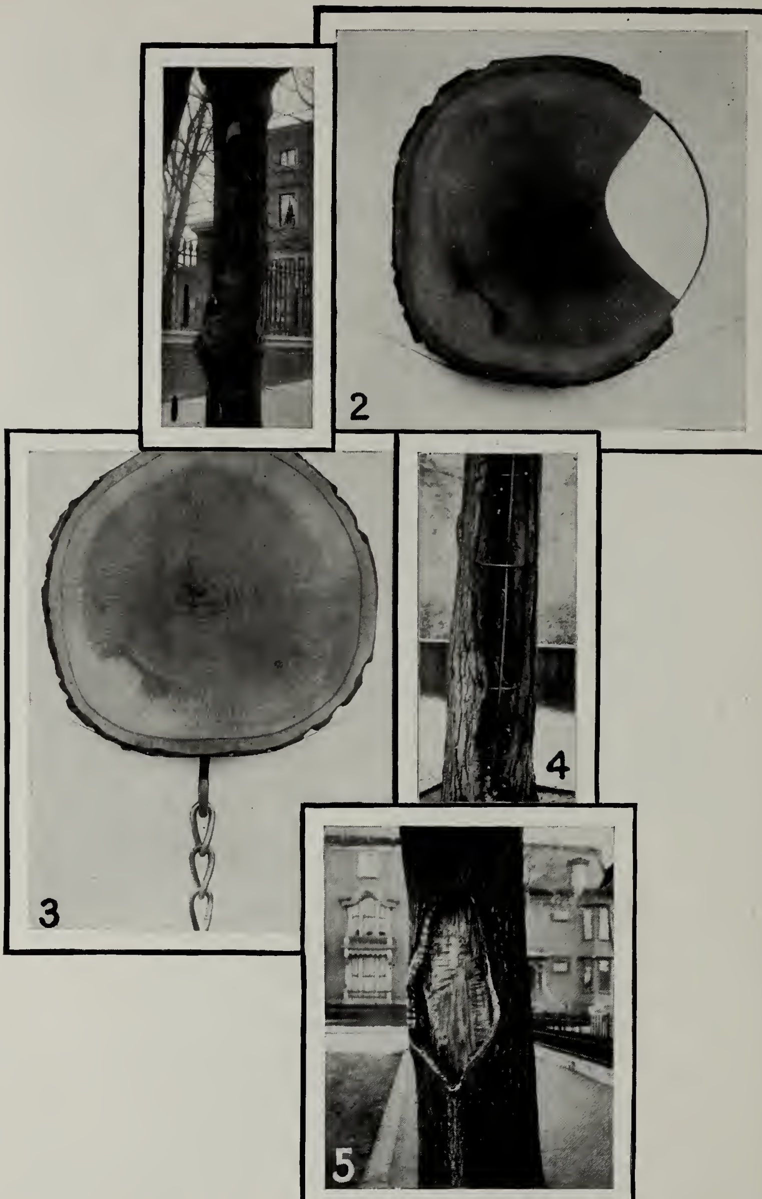
Fig. 1.—Cross section of a young tree trunk showing how the new wood and bark grow into an unfilled cavity from the margin. (The line on the wood indicates the amount of excavating that would be needed before filling the cavity.) Fig. 2.—Cross section of a cavity in a trunk, showing the manner of using a single-headed bolt and of placing nails when there is little or no undercutting. Fig. 3.—Cross section of a tree trunk showing the manner of using two single-headed bolts to brace a cavity. Fig. 4.—The oval washer (the best kind to use) showing the proper method of countersinking and bolting. (Compare also figs. 2 and 3.) Fig. 5.—Cross section of the tree trunk shown in fig. 2 after it is filled with cement. (Note that the surface of the cement conforms with the general shape of the woody portion of the trunk and reaches only to the cambium.)



CEMENT CAVITY FILLINGS, SHOWING DIFFERENT TYPES AND SUCCESSIVE STAGES.

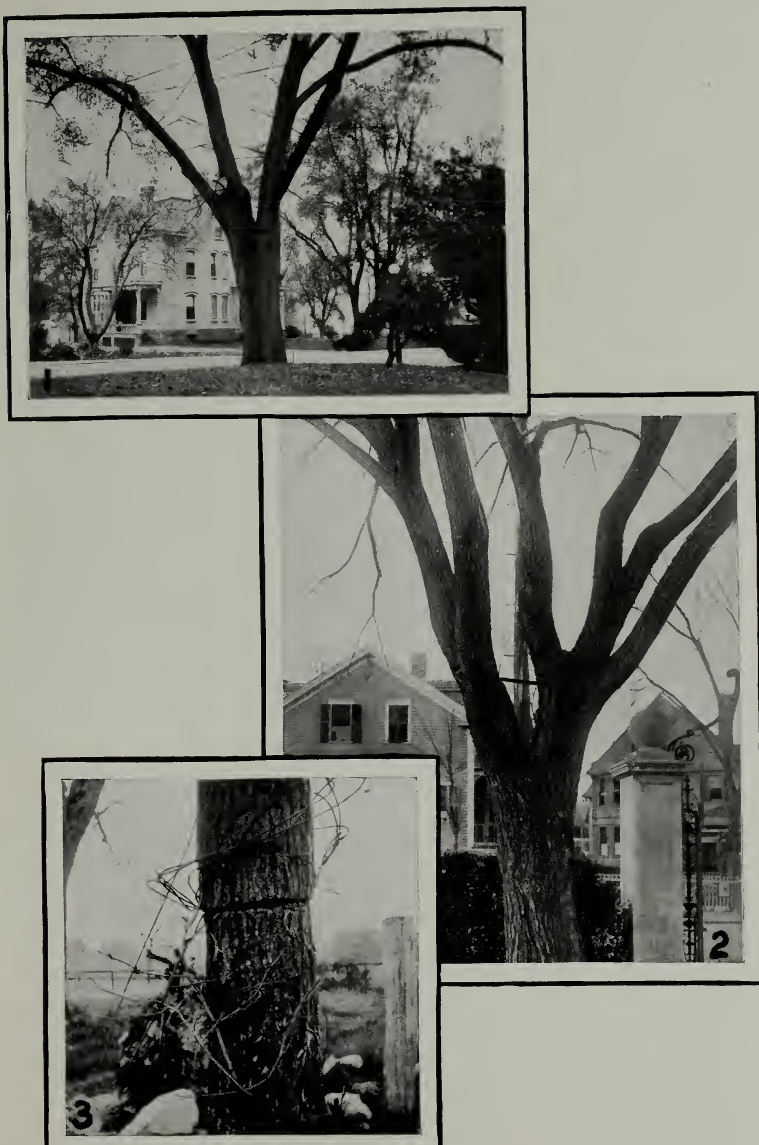
Fig. 1.—A large cavity in an elm filled with cement blocks separated by layers of tarred paper. Fig. 2.—An excavated cavity ready for treating and filling. Fig. 3.—The cavity shown in fig. 2, which has been nailed and partly filled with cement. The ends of the rods for reinforcing the concrete are sprung into shallow holes in the wood. The wire dam is sometimes allowed to remain embedded in the cement, though it is usually removed as soon as the cement has partially set. Fig. 4.—A later stage of the work shown in fig. 3. The height of the wire dam has been increased. Fig. 5.—The same cavity shown in figs. 2, 3, and 4, several days after the filling was completed.

(a patented process)



A DAMAGED CEMENT FILLING, TYPES OF UNCEMENTED CAVITIES, AND CROSS SECTION SHOWING METHOD OF ATTACHING A GUY CHAIN.

Fig. 1.—A cement filling badly shattered by cold weather and swaying of the tree. Fig. 2.—Cross section of a tree trunk, showing method of covering cavities with sheet metal. Fig. 3.—Section of a tree trunk, showing a simple method of attaching a guy chain to a hook bolt. Fig. 4.—A long cavity with nails and cement reinforcing rods in place, ready for filling. This cavity should have been bolted. Fig. 5.—An open shallow cavity ready for creosote and tar. Shallow cavities of this type are not usually filled with cement.



VIEWS SHOWING PROPER METHOD OF FASTENING GUY CHAINS AND BOLTS AND IMPROPER METHOD OF ATTACHING WIRES.

Fig. 1.—Limbs of an elm guyed by several independent chains 15 feet above the crotches. Fig. 2.—A split crotch that has been guyed by means of a long bolt about 18 inches above the crotch. Fig. 3.—A tupelo tree nearly strangled by telegraph wires wrapped around the trunk.

be sufficient before drawing the sides together with bolts. Under certain conditions, particularly in large trees, it may be necessary to use a rope and tackle blocks to pull the limbs together some distance above the crotch, in order to properly close the crack before bolting it. When the tackle blocks are used, care must be taken to have an abundance of bagging or other padding between the bark of the limbs and the encircling ropes. All exposed edges of the crack must now be covered with thick tar. Limbs above split crotches may be guyed. If there is a cavity in the crotch, the limbs above it must be guyed before this cavity is filled.

NAILING.

If the cavity has a comparatively large opening or has little or no undercutting, it is the custom to drive flat-headed wire nails into the wood in the interior in order to hold the cement filling firmly in place. In medium-sized cavities nails 2½ or 3 inches long are usually driven into the wood for about half their length (Pl. XIX, fig. 2). The heads of the nails finally are completely embedded in the cement (Pl. XIX, fig. 5). If the cavity is already bolted, it may not be necessary to use many nails, because the bolts help to hold the cement in place.

TREATING.

After the decayed and diseased matter has been completely excavated and the edges of the sapwood and bark shellacked, the next step is to sterilize the interior of the cavity in order that all germs of disease or decay which are present may be killed and that any which may come in contact with the cut surfaces during subsequent operations may be destroyed. As already stated, creosote appears to be one of the best preparations to use. Every cut part of the wood and bark must be creosoted, and over this a heavy coating of tar or hot asphalt should be applied before the cavity is filled.

MIXING THE CEMENT.

A good grade of Portland cement and clean, sharp sand free from loam (1 part of cement to 3 or less of sand) should be used. The mixing can be done in a mortar bin, a wheel-

barrow, a pail, or in any other available receptacle that is sufficiently large. A quantity of dry cement and sand sufficient to fill the cavity should be thoroughly mixed before the requisite amount of water to make a rather stiff mortar is added and the whole mixture worked to an even consistency. In large cavities fine gravel free from loam is sometimes substituted for the sand.

CEMENTING.

For placing the mixture in the cavity a mason's flat trowel and an ordinary garden trowel with a curved blade will be found convenient. A tamping stick, 1 or 2 inches thick and 1 to 3 feet long, according to the size of the cavity, will be needed; also some rocks and a pail of water if the cavity is a large one. A layer of cement 2 or 3 inches deep can now be placed in the bottom of the cavity with the garden trowel and tamped firmly in place. This operation is repeated until the cavity is filled ~~cement is 8 to 12 inches thick.~~ Wet rocks of various sizes may be embedded in the cement provided they do not reach within an inch or two of its outer face. If the mixture is too wet, it will tend to run out of the cavity under the operation of tamping. If too little water has been used, it will not pack down promptly. ~~The top of the 8 to 12 inch block of cement~~ is ~~then smoothed with the flat trowel so that it will slant slightly downward from back to front, in order to facilitate drainage. Over the top of this cement block a double or single sheet of tarred roofing (or thinner) paper is placed after it has been cut so as to fit the cavity~~. ~~On top of this, another block of cement is built as soon as the first block is sufficiently hard to stand the weight and tamping without forcing any of it out at the bottom of the cavity.~~ If the interior of the cavity extends well above the level of the external opening, it may occasionally be necessary to bore or cut a downward slanting hole from the outside to the top of the interior cavity, through which a watery mixture of cement may be poured to fill the upper part of the cavity and the hole. The main opening of the cavity must be completely closed with the stiffer cement before this watery mixture is introduced. When ~~a block of~~ the cement has partially hardened, it will be necessary to carefully smooth the outer surface or cut it down with the flat trowel to the level of the cambium, taking

great care that the latter is not injured in the operation (Pl. XIX, fig. 5, and Pl. XX, fig. 1). If the cement is allowed to become too hard to trim with the trowel, it can still, with more or less difficulty, be cut back to the cambium line with a cold chisel and hammer. It is a rule with most tree surgeons to trim back the outer surface of the cement to an eighth of an inch or more below the cambium and then use a layer of stronger cement (one part of cement to one to two of sand) to raise it to the level of the cambium, after the filling has partially hardened.

The thinner mixtures of cement will set more firmly. If any mixtures thinner than the one already mentioned are used to fill a cavity, some sort of cloth or wire dam will have to be used to hold the cement in place until it is hard. For this purpose strips of burlap wrapped tightly around the tree so as to cover the lower part of the opening may be sufficient if the mixture is not very thin; otherwise, a more closely woven fabric, such as canvas or carpet, may be used. This dam at first should cover about a foot of the lower part of the opening. The cavity is then filled with cement to the top of the dam. Wet rocks may be embedded in the cement if they are kept well back from the face of the filling. ~~The top is smoothed and covered with tarred paper, as already described,~~ The height of the dam is increased, and the operation repeated. Before the cement has become too hard, the dam is removed and the surface of the cement finished in the usual manner, either to the level of the cambium at once, or it may be cut a little farther back and a finishing layer of stronger cement applied to bring the surface to the proper level. The surface of the cement must be wet before the stronger finishing layer is applied.

A very large proportion of the cemented cavities which are seen in trees at the present time are made in one piece, ~~without the use of tarred-paper partitions~~. Long cavities ~~of this sort~~ are particularly subject to the defects mentioned under the next topic, and ~~one-piece fillings~~ are not recommended except for short cavities where these particular objections do not apply. The method ~~employed is only a slight modification of that already described and~~ will readily be understood by a study of Plate XX, figures 2, 3, 4, and 5, and the legends which accompany them. These figures show successive stages of work in the same cavity.

The edges of cement fillings in the crotches of limbs are especially difficult to keep water-tight. Besides bolting the cavity and guying the limbs above it, the crevices at the edges of such cement fillings must be made as nearly waterproof as thick tar or asphalt can make them.

After the cement filling has become thoroughly dry, the outer face may be painted with coal tar or paint, especially around the edges where cracks are likely to appear. This should not be done for several weeks after the cement has been put into the cavity.

DEFECTS IN CEMENT WORK.

Although fillings made with cement mixtures (cement mortar and concrete) have many, and oftentimes serious, defects, this material is so cheap and so easily handled that no other at the present time is so generally used for the purpose in this country. The most serious defects in cement mixtures are directly due to the hardness and rigidity of the cement after it has become dry. This inflexibility results in cracks appearing across the cement of long fillings (~~where not put in in sections or blocks, as recommended here~~) as the tree sways back and forth in the wind (Pl. XXI, fig. 1). Rods for reenforcing the concrete are often placed in large cavities which are to be filled ~~in one block~~ (Pl. XXI, fig. 4).

During a cold period in winter, particularly one that has been preceded by warm weather, the wood of a~~n~~ ~~unbolted~~ cavity may draw away from the cement, often leaving a comparatively wide crack (Pl. XXI, fig. 1). Sometimes, by the contraction of the wood on a cold day, the tree itself will split above or below the filling, or even through the cement ~~when the cavity has been nailed but not bolted.~~ This cracking may be prevented to some extent by having nailed cavities with a vertical partition of tarred paper extending throughout the length of the filling. On the other hand, the cement filling forms a surface over which the new wood and bark can form during the growing season, and if the decayed and diseased matter in the cavity is entirely removed before the cement is used, it very largely, if not entirely, checks further decay. If cracks appear in the cement, or the wood draws away from the cement, or the work is not properly done, decay organisms may again gain entrance at the edge of the cement and cause further trouble.

ASPHALT.

There is such abundant promise of future good results from the use of asphalt and asphalt mixtures for covering pruning wounds and filling cavities that it seems desirable to say a few words regarding asphalt, although at the present time the use of this substance to fill cavities has not passed beyond the experimental stage. For covering large wounds it apparently is not equaled by any substance that has been mentioned in this article. The great objection to its use is the fact that it has to be kept melted and applied while hot. This makes the process rather cumbersome and inconvenient, which in itself is a serious objection from many points of view, although a coating of asphalt, properly applied at the outset, will often last for years without special attention. The use of asphalt will doubtless eventually overcome many of the serious faults which exist in cement as a cavity filler.

TINNED CAVITIES.

Sheet tin, zinc, and iron have been quite extensively used to cover cavities. When properly applied, these coverings often serve to keep out disease and insects for a long time. Oftentimes they are improperly applied, or the cavity is not properly treated. Under such conditions these tin-covered cavities are a greater menace to the tree than open cavities. In preparing a cavity for a sheet-metal covering, all the decayed, diseased, and insect-eaten wood is removed in the manner indicated under cement fillings, with two exceptions: There is no need of undercutting the cavity and there should be a narrow half-inch ledge of wood around the edge of the cavity to which the margin of the sheet metal can be tacked. The excavated cavity must be thoroughly sterilized and waterproofed. The sheet metal should be trimmed so that its edges will exactly fit along the edges of the bark. The metal can then be placed on a block of wood and holes an inch or less apart punched or drilled along its margin, through which long, slender, flat-headed brads may be driven into the ledge of wood around the cavity. The edges of the cavity and the inner side of the metal should now be freshly tarred. The metal is then put in place and nailed with a light hammer, allowing the center of the metal to curve outward, so as to conform to the general shape of the trunk (Pl. XXI, fig. 2).

The curving of the sheet metal will reduce the danger of its being ripped off at one or both edges as a result of the expansion and contraction of the wood caused by changes of temperature. Two or more pieces of sheet metal with overlapping joints should never be used unless these joints are soldered air-tight. The final operation is to tar or paint the outer surface of the metal cover, taking special care that the tacked edges are made as nearly air-tight and waterproof as tar or paint can make them. If the insect tunnels were not all gouged out, the cavity should be fumigated by saturating a wad of cotton waste with carbon disulphid and suspending it in the top of the cavity by means of a string for 12 hours or more before the tin is finally nailed at the top. During the fumigating process the cavity must be tightly closed.

OPEN CAVITIES.

In a tree which is not considered of sufficient value to warrant cleaning and filling the decayed areas or covering them with tin, these may be excavated, sterilized, and waterproofed (Pl. XXI, fig. 5). In this condition they can often be safely left for years if the waterproof covering is renewed as soon as cracks or blisters appear. Cavities treated in this way are probably as safe as ordinary tinned or cemented cavities and have the advantage of easy inspection from time to time. Shallow or large cavities in valuable trees may be very satisfactorily treated in this manner. They are usually preferable to large cement filled cavities The new wood and bark produced by the cambium along the margins will form an inwardly rolled edge (in the manner shown in Pl. XIX, fig. 1), as there is no cement or tin to force it across the cavity.

WHEN TREE SURGERY MAY BE UNDERTAKEN.

As a general rule, tree surgery can be safely undertaken at almost any time of year when the sap is not running too actively and the weather is not cold enough to freeze the cement. In most trees the sap will interfere with the work only from the time the buds begin to expand in the spring until the leaves are full grown. Cement work will be ruined if it is frozen before it is hard. It is not likely to be injured by frost after it has been drying for a week.

GUYING.

Closely associated with the work of tree surgery proper, and often an indispensable adjunct, is the guying of limbs to prevent the splitting of the crotches or to check further splitting. The best place to put these guys depends largely upon the shape and position of the limbs to be braced. This varies so widely in different trees that it will be impossible to give very specific directions for this kind of work.

A simple method of guying a crotch is to place a hook bolt through each limb, with the hooks in the two limbs toward each other and from 3 to 10 feet or more above the crotch (depending upon the size, position, and length of the limbs) and slipping the end link of a stout chain over one of the hooks (Pl. XXI, fig. 3), while at the proper place in the chain to make a sufficiently taut guy a link is slipped over the other hook. The rest of the chain can then be cut away, if desired (Pl. XXII, fig. 1). Modifications of this method may be used where three or more adjoining limbs are to be guyed collectively. A simple method is to place a hook bolt through each limb at the proper place and then hook a link of the chain over each bolt hook at any desired point, one of the hooks serving to hold the two end links of the chain. The precautions already mentioned under "Bolting" should always be followed, so far as they apply to boring and tarring the hole and countersinking the washers of the bolts.

A turnbuckle rod or bolt is much better than a chain when the guy is to be kept perfectly taut at all times. Furthermore, this rod permits a ready tightening of the guy within certain limits, should it later become necessary.

Many people prefer to use a wire cable or a heavy wire in place of the chain as being cheaper and otherwise equally good.

If for any reason the guy is to be placed within a foot or two of the crotch, a single long bolt can often be used to better advantage (Pl. XXII, fig. 2), and sometimes a single long bolt can be used in place of a chain or a turnbuckle rod where the guyed limbs are not likely to twist much as they sway in the wind.

Occasionally it may become necessary to guy a whole tree in order to prevent the breaking of the trunk where an unusually large cavity leaves only a thin shell of sound wood, or to prevent the tree from tipping over. This can be accomplished by attaching four guy chains or ropes to

the tree about halfway from the ground to the top of the tree and having these slant downward at an angle of about 45° to four short, stout posts set firmly in the ground about equidistant around the tree (e. g., on the north, east, south, and west sides of the tree). The method of attaching the guys securely to the posts is immaterial. The method of attaching them to the tree is important. If the guying is for temporary purposes only, two broad bands of leather or stout canvas or other strong material, each long enough to make a loop at least twice the diameter of the trunk or limb to be encircled and 4 to 6 inches wide, may be passed around the tree or some favorably situated limb and two adjoining guys attached to each loose loop. If a more permanent guying is needed, two eyebolts (or hook bolts) can be placed through parallel creosoted holes in the trunk or limb about halfway up the tree, one about 6 inches above the other. The eye of one bolt should be on the opposite side of the tree from the other. Two guys from two adjoining posts are attached to each eyebolt. The chafing of a limb against a guy can be prevented by padding the guy if the latter can not be so placed as to clear all limbs.

Limbs or trees should never be guyed by passing wires, chains, or ropes tightly around them. These may eventually strangle the portions beyond the encircling band. Encircling fence wires, telegraph wires, clotheslines, or guy wires will act in the same way, killing all parts of the tree beyond the wires if these remain tightly drawn around the limb or trunk for any great length of time—occasionally in less than a year (Pl. XXII, fig. 3).

TREES WORTH REPAIRING.

Most ornamental and shade trees having only a few dead limbs are unquestionably worth attention. Others which have many dead limbs or numerous decayed areas may not be worth the expense, particularly if they are naturally rapid-growing, short-lived trees. No one can decide better than the owner of a tree whether it is worth the attempt to save it, because usually the actual commercial value of an ornamental or shade tree has little or nothing to do with the decision. It is generally a question merely of esthetic value, or historic associations, or rarity of the species. A man who has had experience in repairing muti-

lated or diseased trees may be able to say definitely whether it is possible to save the tree, but the owner, who pays the bill, is the one who will have to decide whether the tree is worth the price it will take to repair it. Often the owner will realize a greater degree of satisfaction by having a badly diseased or mutilated tree replaced. In expert hands the moving of large trees is no longer a hazardous undertaking.

COMMERCIAL TREE SURGERY.

GENERAL DISCUSSION.

For a number of years, but particularly within the last decade, the demand for reliable men to repair decaying ornamental and shade trees has greatly increased. This has led many persons and firms to take up this class of work, often as their main line, though more commonly in connection with some nearly related line of work. At the present time there are numerous firms upon whom the property owner may call if he prefers to hire commercial tree surgeons to attend to his trees. In this line of work, as in others, will be found the honest and dishonest man, the reliable and unreliable firm, competing for contracts to care for trees. The earlier pages of this article have been devoted primarily to the interests of the man who prefers to attend to his own trees, or to have one of his regularly employed workmen do it, or to supervise personally the work being done by others. The remaining pages will be devoted primarily to the interests of the tree owner who hires commercial tree surgeons to attend to his trees.

CONTAGIOUS DISEASES.

The writer's observation of the workmen employed in commercial tree surgery leads to the conclusion that few have any knowledge of the manner of growth of fungi which cause disease in trees, or, if they do know something about it, they apparently do not allow this knowledge to modify their methods appreciably. It is extremely important that special precautions be taken when a contagious disease, such as the chestnut bark disease, is infecting a tree. As an illustration of how two types of firms have handled

matters of this nature in the past, two cases out of many which have come to the writer's attention are cited.

A few years ago a firm of tree surgeons obtained a contract to repair the trees on a Long Island estate. Among the trees was a very large old chestnut, which was much prized by the owner, who desired to have it saved. The tree was badly infected with the bark disease and was far beyond recovery at the time the work was undertaken. However, this did not deter the contractors from doing a great amount of work on it, including excavating a cavity in the interior of the tree more than 20 feet long and from 3 to 4 feet in diameter. The foreman in charge informed an inquirer that more than 5 tons of cement (concrete) had been used in filling this one cavity and that it had taken several men a certain number of weeks to do the work. On the day the work was completed the spore threads of the disease-producing fungus were present in great numbers in the furrows of the bark over a large portion of the trunk. The tree was entirely dead in less than 12 months, although the superintendent of the estate was assured by the foreman in charge of the work that the tree would be "alive and flourishing at the end of five years' time."

In contrast, another well-known firm, of a different type, was asked to repair and prune a large chestnut tree on Long Island. The price was to be governed by the amount of work actually done. This tree had several dead limbs and was supposed to be defective in other ways. Before undertaking the work, a man who was well acquainted with the chestnut bark disease was asked by the firm that expected to get the contract to examine the tree. This was done. The examination revealed the fact that the tree had numerous areas of the disease on the trunk and that some larger limbs had been killed by it. Upon receipt of this information the firm declined to undertake any work on the tree, although a half day had been consumed in hauling ladders, tackle, and three men in a two-horse team to the tree in order that a thorough preliminary examination might be made.

The natural inference is that one firm had no interest beyond collecting a good sum of money for work that was worse than useless, while the other placed the maintenance of a good reputation ahead of everything else. One firm

was the worst type of enemy to honest commercial tree surgery; the other, a worthy supporter of it.

IGNORANT WORKMEN AND FAKERS.

Unfortunately for tree owners and the trees themselves, many men who are set at work by an unreliable contractor know little or nothing of the fundamental principles concerning the life history of a tree. In their ignorance, such workmen are likely to make serious blunders through neglecting to do certain important things the reason for which they can not understand. The faker will always slight any stage of the work, no matter how important, if evidence of his neglect can be effectually obliterated or hidden by subsequent operations. There are few more favorable opportunities for practicing frauds of this nature than in the operation of filling cavities in trees. The decayed and diseased wood may be only partially removed, improper or no antiseptic coatings used in the cavity, or no proper drainage provided, yet no one can tell the difference after the cavity has been filled or covered unless the filling or covering be removed. A cavity filled with cement or other material before the decayed and diseased wood has been wholly removed is nearly comparable to a tooth from which the decayed matter has been only partially removed by the dentist before it is filled.

MISUSE OF THE PRUNING HOOK.

Too commonly the ordinary workman will get into the top of a tree and use his long pruning hook to break off the small dead branches, in the same manner that he would use a club for a like purpose. When so used, the pruning hook will inevitably cause many injuries to the young bark of adjoining branches and make wounds through which disease and decay germs can enter. In this manner many new openings for the possible entrance of disease may be created, in addition to the one already existing in the dead branch, for it must be remembered that merely breaking off the branch does not prevent decay from continuing at this point, while every new bruise or wound may furnish a new point for decay to enter.

CLIMBING DEVICES.

On various occasions we have seen workmen in the employ of well-known tree-surgery firms repeatedly jab their climbing spurs into the bark on horizontal limbs where it would have been much easier for them to move about without using spurs at all. The use of climbing spurs on trees should be avoided, or at least severely discouraged. It would be best if they were never used. Every wound made by one of these spurs may become the center of a new region of decay if conditions favorable for the growth of decay organisms exist. The use of spurs should be strictly prohibited on all parts of a tree subject to a contagious disease above ground, especially if the disease is known to exist in the vicinity. A man who uses spurs on the trunk or on limbs that can readily be reached by a light ladder should never be allowed to work on trees. Firms who permit their workmen to do this should be classed as undesirable or dangerous firms to deal with and accordingly avoided. Many trees have been irreparably damaged and left in far worse condition after ignorant or indifferent workmen equipped with climbing spurs and pruning hooks have worked in them than if nothing had ever been done to them. The edges of the soles and heels of leather shoes, to say nothing of protruding nails, commonly cause considerable injury to soft and tender bark. Probably the best and safest footwear, from the point of view of preventing injury to the tree, is some form of rubber-soled shoe, such as tennis shoes or "sneaks." All properly equipped firms of tree surgeons have ladders that will reach 40 or 50 feet or more into a tree. Ladders, ropes, and rubber-soled shoes will allow a man to reach practically every part of a tree that can be reached by climbing spurs.

Reliable estimates indicate that it takes somewhat longer (perhaps 25 per cent on an average) to do the required work on a tree when ladders, ropes, and rubber-soled shoes are used instead of climbing spurs. Consequently, it may be expected that contractors will have their workmen use spurs unless these are specifically prohibited.

RESPONSIBILITY OF TREE OWNERS.

Owners who contract with a firm of tree surgeons to attend to their trees are occasionally quite as much to be blamed for the resulting poor work as the men who do it. This statement refers to those owners who get an estimate for having their trees repaired in a proper manner by men who make a business of caring for trees, and then say, in effect, "I've got only half that amount of money for the work, and you will have to do it for that or I will get some one else to do it." The reliable man who has named a price that will insure at least reasonably good work has to do one of two things under those conditions; either he must decline to do the work or he must lower his price. When these conditions arise, the work is often undertaken at a reduced price. This generally means that the work has to be of a cheaper grade, possibly done by inexperienced men, in order that a profit can be realized. A wiser course for the owner would have been to put his available money into repairing in a proper manner the more valuable of his trees, leaving the less valuable ones untreated.

Perhaps in other cases the owner, after getting the estimate for good work from a reliable firm, will go to another firm, possibly a notoriously unreliable one, and obtain a considerably lower price for the work. Commonly in neither instance have any specifications been considered covering just what should be done to the trees beyond the assurance of the contractor that the trees would be fixed up "as they should be" or "in fine condition." With no more definite understanding than this, too much of the work in the past has been done. In many cases, two or three years later, the owner learns to his chagrin (usually from his own observations) that the work was not properly done and that his money was little better than thrown away. Property owners who have passed through experiences of this sort are often the bitterest opponents of tree repairs and the most caustic and indiscriminate critics of all persons engaged in this type of work. It might be well for such tree owners to ask if, in refusing to pay the price for good work, or in permitting incompetent men to do it merely because they make a lower bid than any reliable man could afford to, they themselves are not equally to be

blamed for the poor work. Two men may have very different standards as to what should be done to a tree or what they intend to do to it.

With the completion of tree-surgery work, owners usually fail to realize the importance of keeping close watch of their trees, in order that defects which appear in the work may be remedied promptly and that new injuries elsewhere on the tree may have immediate attention. If a tree is considered by its owner of sufficient value to warrant having it properly and carefully treated by a tree surgeon, it certainly is worth the slight expense of subsequent annual or biennial inspection and the immediate repair of newly discovered injuries at a time when the expense necessary to keep the tree in good condition will be comparatively small.

It should be borne in mind that scars remaining after large limbs have been removed or large cavities cemented are commonly unsightly spots for years, even under the best of conditions. If the scar is a large one, it may never entirely heal over and may consequently remain a conspicuous defect. It might so happen that a particularly large scar would be too unsightly and conspicuous to please the owner, should the decayed matter be removed properly and the cavity filled. Under such conditions he may realize a greater amount of satisfaction in the end by having the diseased tree replaced with a healthy one. For several years at least one well-known firm of nurserymen has been moving large trees (with trunk diameter of a foot or more) with remarkable success; at the same time demonstrating the possibility of moving good-sized healthy trees without their showing apparent adverse symptoms afterwards. Thus it is possible often to replace a diseased tree with a healthy one of similar size without having to wait 15, 20, or more years for it to attain the size of the displaced one.

CONTRACTS.

In order to secure better results in the future than have generally been attained in the past, and to put commercial tree surgery on a basis that will tend to eliminate the fakers, owners are urged to have a definite written contract with tree surgeons whom they employ to take care of their trees.

The best results can generally be attained when payment is to be based upon the amount of work done plus the cost of materials used. Probably most persons, however, will prefer to have the trees examined and a definite price agreed upon before any work is undertaken. In either case there should be a definite written understanding concerning at least certain important phases of the work, in addition to price and methods of payment. The following is suggested as a model for such contract:

(1) No climbing spurs shall be used on any part of a tree.

(2) The shoes worn by the workmen shall have soft rubber bottoms.

(3) Ordinary commercial orange shellac shall be applied to cover the cut edges of sapwood and cambium within five minutes after the final trimming cut is made.

(4) All cut or shellacked surfaces shall be painted with commercial creosote, followed by thick coal tar.

(5) All diseased, rotten, discolored, water-soaked, or insect-eaten wood shall be removed in cavity work and the cavity inspected by the owner or his agent before it is filled.

(6) Only a good grade of Portland cement and clean, sharp sand in no weaker mixture than 1 to 3 shall be used to fill cavities.

(7) The contractor shall repair free of expense any defects that may appear in the work within one year.

If the owner prefers to have a cavity filled with asphalt or other material instead of cement, the contract can be altered accordingly. If it is desirable to substitute some other preparation for shellac, this can be done. Similarly, under certain conditions, various other modifications may be made, although alterations in Nos. 1, 2, 5, and 7 should be made with caution. It may so happen that if all insect-eaten wood is removed, the tree may be dangerously weakened; under such conditions the diseased matter can be removed to solid wood and the cavity fumigated, as described under "Tinned cavities," or the tree may be guyed. If certain crotches are split or particular limbs on some trees need guying, it may be well to include these items in the contract. It may be desirable to include a statement of just what limbs shall be removed from particularly choice trees, and some provision should always be made for the regular inspection of the trees every one or two years.

CONCLUDING REMARKS.

At the present time the science of tree surgery has not attained the recognition and approval from tree owners that it deserves. This may be due in part to the unfavorable impressions created from experiences with fakers, but probably primarily from the disinclination of the owners to spend much money in preserving their trees or from their ignorance of the benefits that may accrue from tree surgery when properly done. Reliable tree surgeons are doing much in a practical way to educate the public as to the benefits of tree surgery. Unfortunately, the unreliable tree surgeons are doing much to offset it.

There are methods connected with the work that may in the near future prove to be far superior to some now in common use and recommended here. At present, experiments to test the efficiency of some of these have not been conclusive.

The Department of Agriculture invites correspondence, either from individuals or firms, concerning new methods of treatment or prospective methods, and will be prepared to advise for or against any particular method so far as experience and the results of experiments will permit. It is only by cooperation of this sort that tree surgery can ultimately attain the position that it deserves in the estimation of the general public.

Finally, tree owners are urged to remember at all times the axiom: *The need of tree surgery 15 or 20 years hence may be very largely obviated by promptly attending to the fresh injuries of to-day.*

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